Thesis/
Reports
Bevins,
C. D.

LIGHTNING FIRE DENSITIES

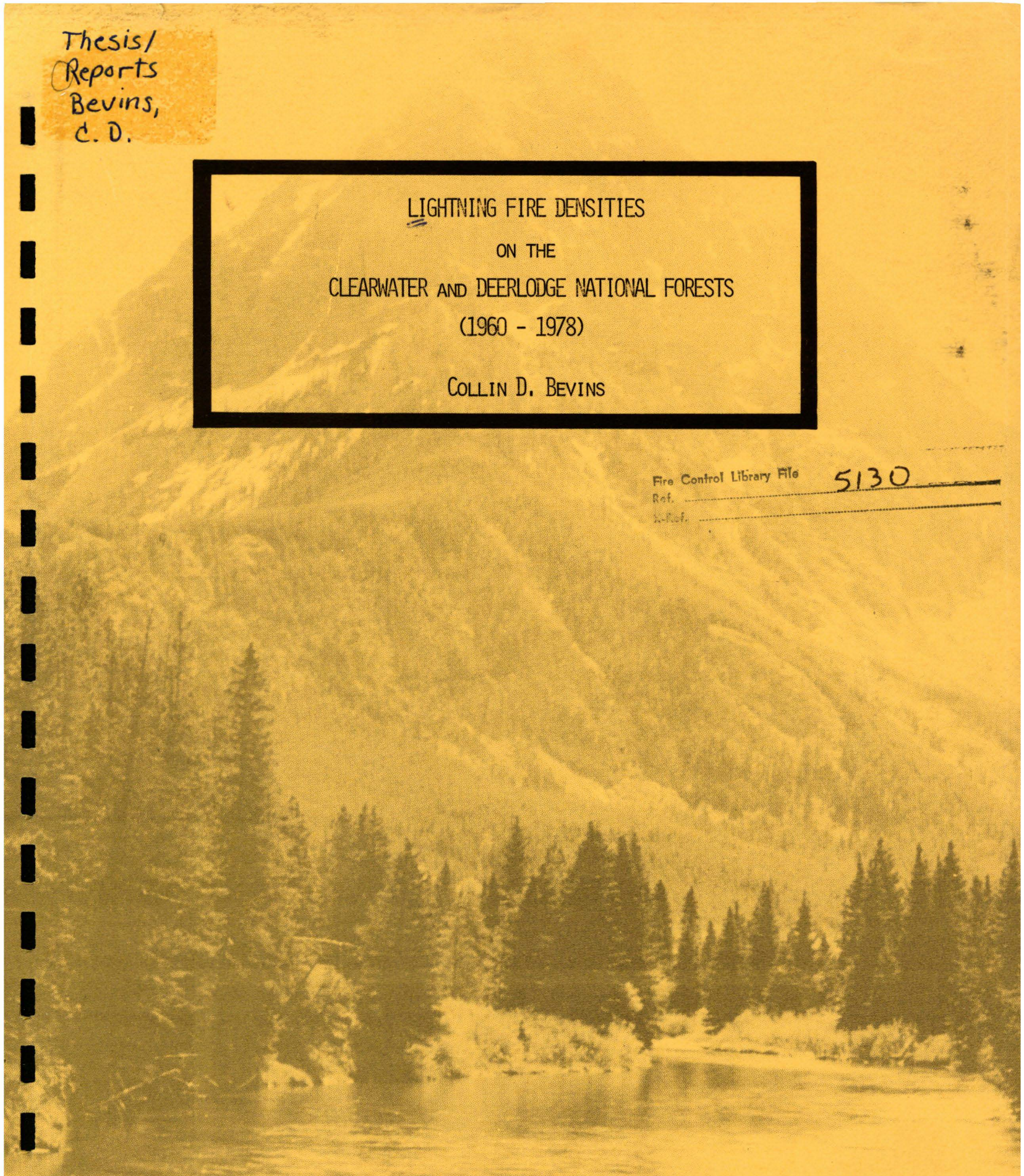
ON THE

CLEARWATER AND DEERLODGE NATIONAL FORESTS

(1960 - 1978)

COLLIN D. BEVINS

Fire Control Library File 5130
Ref. .....
Ref. .....



SYSTEMS FOR ENVIRONMENTAL MANAGEMENT

P. O. BOX 3776
MISSOULA, MONTANA 59806
PHONE: (406) 549-7478

Property of
National FS Library
USDA Forest Service
240 W Prospect Rd
Fort Collins CO 80526

Final Report for Research Agreement
#12-11-204-153
Systems for Environmental Management
FS Contact: James E. Lotan
Coop Contact: Collin D. Bevins

LIGHTNING FIRE DENSITIES ON THE CLEARWATER AND DEERLODGE NATIONAL FORESTS

(1960 - 1973)

SUBMITTED BY

COLLIN D. BEVINS
PRINCIPAL INVESTIGATOR
SYSTEMS FOR ENVIRONMENTAL MANAGEMENT
MISSOULA, MONTANA

SUBMITTED TO

FIRE IN MULTIPLE USE MANAGEMENT RD&A PROGRAM
NORTHERN FOREST FIRE LABORATORY
INTERMOUNTAIN FOREST & RANGE EXPERIMENT STATION
USDA FOREST SERVICE
OGDEN, UTAH

AND

OFFICE OF FIRE & AVIATION MANAGEMENT
NORTHERN REGION
USDA FOREST SERVICE
MISSOULA, MONTANA

OCTOBER 26, 1979

LIGHTNING FIRE DENSITIES ON THE CLEARWATER AND DEERLODGE NATIONAL FORESTS

Submitted by: Collin D. Bevins 10-26-79

Collin D. Bevins, Research Supervisor, Systems for Environmental Management, Missoula, Montana

Recommended by: _____

Charles P. Kern, Regional Fire Coordinator, Fire & Aviation Management, Northern Region, USDA Forest Service

Approved by: _____

Dr. James E. Lotan, Program Manager, Fire Effects RD Program, Intermountain Forest & Range Experiment Station, Northern Forest Fire Laboratory, USDA Forest Service

PREFACE

"Lightning Fire Densities on the Clearwater and Deerlodge National Forests" is the final report to Master Memorandum of Understanding No. 12-11-204-153, Supplement No. 9, between Systems for Environmental Management, Missoula, Montana, and the Intermountain Forest & Range Experiment Station, USDA Forest Service, Ogden, Utah.

Financial and computer systems support for the study was provided by Systems for Environmental Management, Collin D. Bevins, Principal Investigator; the Fire in Multiple Use Management RD&A Program, Dr. James E. Lotan, Program Manager, and Dr. Richard J. Barney, Research Forester; and the office of Fire & Aviation Management, Northern Region, USDA Forest Service, Charles P. Kern, Regional Fire Coordinator.

A special note of thanks to computer specialists Cameron Johnston, Fire & Aviation Management office, and Moxon Hart, Timber Management office, for their help in retrieving data essential to the completion of the study.

CONTENTS

PREFACE i

CONTENTS ii

I. INTRODUCTION 1
A. Fire Density 1
B. Study Objectives 2

II. STUDY DESIGN 3
A. Study Scope 3
B. Study Stratifications 4
1. Forest Cover Type Stratification Classes 4
2. Stand Condition Stratification Classes 5
3. Elevation Band Stratification Classes 5
C. Study Variables 6
1. USDA Forest Service administered acreages 6
2. Lightning fire occurrence 6
3. Lightning fire density 6
4. Lightning fire acres burned 6
5. Percent area burned per annum 7

III. STUDY METHODS
A. Cover Type Stratification Analysis 8
B. Stand Condition Stratification Analysis 11
C. Elevation Band Stratification Analysis 15
D. Computation of Fire Variables 15

IV. RESULTS 17

V. DISCUSSION 48
A. National Forest 48
B. Forest Cover Types 49
C. Stand Condition 50
D. Elevation Band 51

VI. FOOTNOTES 52

VII. PUBLICATIONS CITED 52

I. INTRODUCTION

A. Fire Density

The conversion of forest fire occurrence numbers into fire density estimates has recently become possible with the advent of forest-wide inventory procedures on USDA Forest Service national forests (1,2). Forest fire density is simply the number of fires occurring within a specific forest area or type over a period of time normalized by the land area of the forest type. Fire density is usually expressed in units of reported fires per million acres per year.

By way of example, if 20 lightning fires had been reported on 200,000 acres of stocked ponderosa pine lands over a 10 year period, the resulting fire density would be:

$$\frac{\text{20 lightning fires}}{\text{0.2000 million acres x 10 years}} = \text{10 fires/mm acres/year.}$$

The only information required to compute fire density is (1) fire occurrence data stratified by forest area or type and (2) land area estimates for the identified forest areas or types.

The first data requirement is fulfilled by the Individual Fire Report (5100-29) forms filed for each fire reported on USDA Forest Service administered lands. The reports include information on fire date, origin, cause, and stand and site factors at the point of origin.

The second data requirement has been met by forest-wide inventory procedures adopted for Northern Region national forests in the early 1970's. The procedure randomly selects national forest areas with probability proportional to size for inventory sampling (Stage and Alley, 1972). Selected areas are inventoried for a variety of stand,

site, and resource factors. The procedure enables statistically-valid extrapolation of sampled forest acreages to forest-wide estimates by stratification class with associated measures of sample error.

Several stand and site factors are common to both the Individual Fire Reports and forest inventory procedure. Those of perhaps greatest interest with respect to fire density estimation are forest cover type, stand condition, and elevation.

B. Study Objectives

The objectives of the study are:

1. to perform operational testing and field evaluation of a methodology to determine lightning fire occurrence densities on Northern Region national forests,
2. to interface lightning fire occurrence density determination methods and results with Northern Region fire planning efforts, and
3. to determine the effects of forest cover type, elevation, stand condition, and lightning fire regime (east vs. west side forests) on lightning fire occurrence density for two Northern Region national forests.

II. STUDY DESIGN

A. Study Scope

The study was limited to the determination of fire density estimates for lightning-caused forest fires reported on non-wilderness portions of the Clearwater and Deerlodge National Forests from 1960 through 1978, inclusive. People-caused forest fires were not included in the analysis. Wilderness fires were omitted because corresponding wilderness acreage estimates by forest cover type, stand condition, and elevation band were not available from the forest inventory. The 19 year study period was considered adequate and representative of the lightning fire regime on the two national forests.

The Clearwater National Forest lies along the west side of the Bitterroot Mountains in north-central Idaho. It is a 'west side' forest considered to have a high fire load. The Deerlodge National Forest encircles the Sapphire Mountains in west-central Montana. It is an 'east side' forest with a historically low fire load. Over the 19 year period studied, the Clearwater National Forest reported a total of 1600 lightning fires on inventoried lands, while the Deerlodge National Forest reported 362 lightning fires. Their respective overall lightning fire densities are 50 lightning fires per million acres per year for the Clearwater, and 16 lightning fires/mm acres/year for the Deerlodge.

B. Study Stratifications

Lightning fire density estimates were made separately for the Clearwater and Deerlodge National Forests. The analysis was repeated for 3 stratification schemes on each forest; forest cover type class, stand condition class, and elevation band.

1. Forest Cover Type Stratification Classes

(1) Douglas-fir (includes Douglas-fir - lodgepole pine mixed types on the Deerlodge National Forest)

(2) Western larch - Douglas-fir mixture (includes WL-DF, PP-WL-DF, and WL-PP-DF mixed types)

(3) Grand fir - western larch - Douglas-fir mixed type

(4) Ponderosa pine

(5) Western white pine

(6) Lodgepole pine

(7) Spruce

(8) Western red cedar and/or western hemlock

(9) Subalpine types (includes spruce-subalpine fir, subalpine fir, whitebark-limber pine, alpine larch, and mountain hemlock in pure or mixed types)

(10) Hardwoods (includes aspen, cottonwood, green ash, and box elder)

(11) Other stockable (commercial) cover types

(12) Stockable subtotal (total of classes 1 through 11)

(13) Nonstockable lands

(14) Unknown or uncoded

(15) Forest inventory total

2. Stand Condition Stratification Classes

(I) Seedling - sapling stands

(2) Poletimber stands

(3) Mature sawtimber (uncut, unthinned) stands

(4) Stocked timberland subtotal (total of classes 1 through 3)

(5) Thinning slash (mature, thinned stands)

(6) Logging slash (cutover stands without slash disposal or site preparation)

(7) Disposed slash (cutover stands with hazard reduction or site preparation)

(8) Stockable timberland subtotal (total of classes 4 through 7)

(9) Nonstockable areas (noncommercial forest, nonforest, water)

(10) Unknown or uncoded

(11) Forest inventory total

3. Elevation Band Stratification Classes

(1) 1000 - 1999 feet

(2) 2000 - 2999 feet

(3) 3000 - 3999 feet

(4) 4000 - 4999 feet

(5) 5000 - 5999 feet

(6) 6000 - 6999 feet

(7) 7000 - 7999 feet

(8) 8000 - 8999 feet

(9) 9000 feet plus

(10) Subtotal (total of classes 1 through 9)

(11) Unknown or uncoded

(12) Forest inventory total

C. Study Variables

The following acreage and fire variables and their associated statistics were used to analyze fire densities within the above stratification schemes for each national forest:

1. USDA Forest Service administered acreages

   a. annual mean estimate
   b. annual standard deviation about the mean
   c. percent standard deviation
   d. percent of forest inventory total acreage within the class

2. Lightning fire occurrence (must have started on USDA Forest Service administered nonwilderness lands)

   a. annual mean
   b. annual standard deviation about the mean
   c. annual median
   d. study period total

3. Lightning fire density (fires per million acres per year)

   a. annual mean
   b. annual standrad deviation about the mean
   c. annual median
   d. relative fire density rating (based on the stratification class with the highest fire density)

4. Lightning fire acres burned (must have started on USDA Forest Service administered nonwilderness lands)

   a. annual mean
   b. annual standard deviation about the mean
   c. annual median
   d. study period total

5. Percent area burned per annum

   a. annual mean
   b. annual standard devaition about the mean
   c. annual median
   d. burnover rate (number of years for the class's acreage to burn over one complete time at the mean annual % area burned per annum rate)

III. STUDY METHODS

A. Cover Type Stratification Analysis

Lightning fire occurrence and acreage by cover type class was determined from the Individual Fire Report (5100-29) forms and the FINSYS forest inventory database, respectively. Forest cover type classes from the two sources were re-assigned to the study stratification classes as in Figure 1.

Study Classes		5100-29 Classes		FINSYS Classes	
Code	Cover Type	Code	Cover Type	Code	Cover Type
1	DF	0	DF	1	DF
				4	DF-LP
2	WL-DF	1	WL-DF	55	WL-DF
	PP-WL-DF	4	PP-WL-DF	57	WL-PP-DF
	WL-PP-DF				
3	GF-WL-DF	2	GF-WL-DF	56	GF-WL-DF
4	PP	3	PP	11	PP
5	WWP	5	WWP	21	WWP
6	LP	6	LP	61	LP
7	Spruce	7	Engelmann spruce	35	Engelmann spruce
8	WRC	8	WRC-WH	41	WRC
	WH			48	WH
9	Subalpine types	91	Subalpine	36	AF-spruce
				47	Mtn Hemlock-AF
				58	AL-AF-WLP
				62	WLP
				96	WLP-AF-AL
10	Hardwoods	92	Deciduous	80	Hardwoods
				82	Birch-Green Ash-Box Elder
				83	Aspen
				85	Cottonwood

Figure 1. Forest Cover Type Class Determination

Study Classes		5100-29 Classes		FINSYS Classes	
Code	Cover Type	Code	Cover Type	Code	Cover Type
11	Other Stockable			93	Juniper-Pacific Yew
12	Stockable Subtotal				
13	Nonstockable	93	Brush	90	Noncommercial forest
		94	Grass-Weeds	99	Noncommercial forest
		95	Grass-Sage		
14	Unknown	00	uncoded	00	uncoded
15	Forest total				

Figure 1. (cont.)

B. Stand Condition Stratification Analysis

The acreage distribution among stand condition classes changes from year to year as a result of forest management practices. Such yearly acreage changes were not recorded in the forest inventory since it is a one time only procedure. The FINSYS database does, however, provide estimates of seedling-sapling, poletimber, sawtimber, and nonstocked class acreages. This data was supplemented with information from the Stand Examination and Management Status Record (Reference FSH 2411.15 R1) to determine forest management activities and dates during the study period.

The FINSYS database was used to obtain baseline acreage estimates for seedling-sapling, poletimber, and sawtimber classes during the year of inventory. The Stand Examination and Management Status Record (SEMSR) was then used to compute acreage distributions before and after the year of inventory. This was accomplished using a forest management cycle model to redistribute acreages among the stand condition classes based upon yearly management activities and forest growth (Figure 2). The model identifies 10 pathways by which acreages have passed through the 6 stand condition classes of seedling-sapling, poletimber, sawtimber, thinning slash, logging slash, and disposed unregenerated sites during the 19 year study period. The remaining 5 stand condition classes of stocked subtotal, stockable subtotal, nonstockable, unknown, and forest inventory total were considered constant through time.

The 1970 decade 5100-29 forms explicitly recognized all 6 of the dynamic stand condition classes. The 1960 decade 5100-29 forms, however, only coded fires by seedling-sapling, poletimber, sawtimber, and 'cutover' classes. The 'Specific Fuel - Point of Origin' entry was

used to determine if the stand was in the tinning slash, logging slash, or disposed slash condition. If the stand was 'mature-uncut' with 'slash-new' or 'slash-old' fuels, it was considered thinning slash. If the stand was 'mature-cutover' with 'slash-new' or 'slash-old', it was assigned to the logging slash class. If it was 'mature-cutover' and the fuel type was not slash, it was considered to be disposed slash.

Figure 2. Forest Management Cycle Model

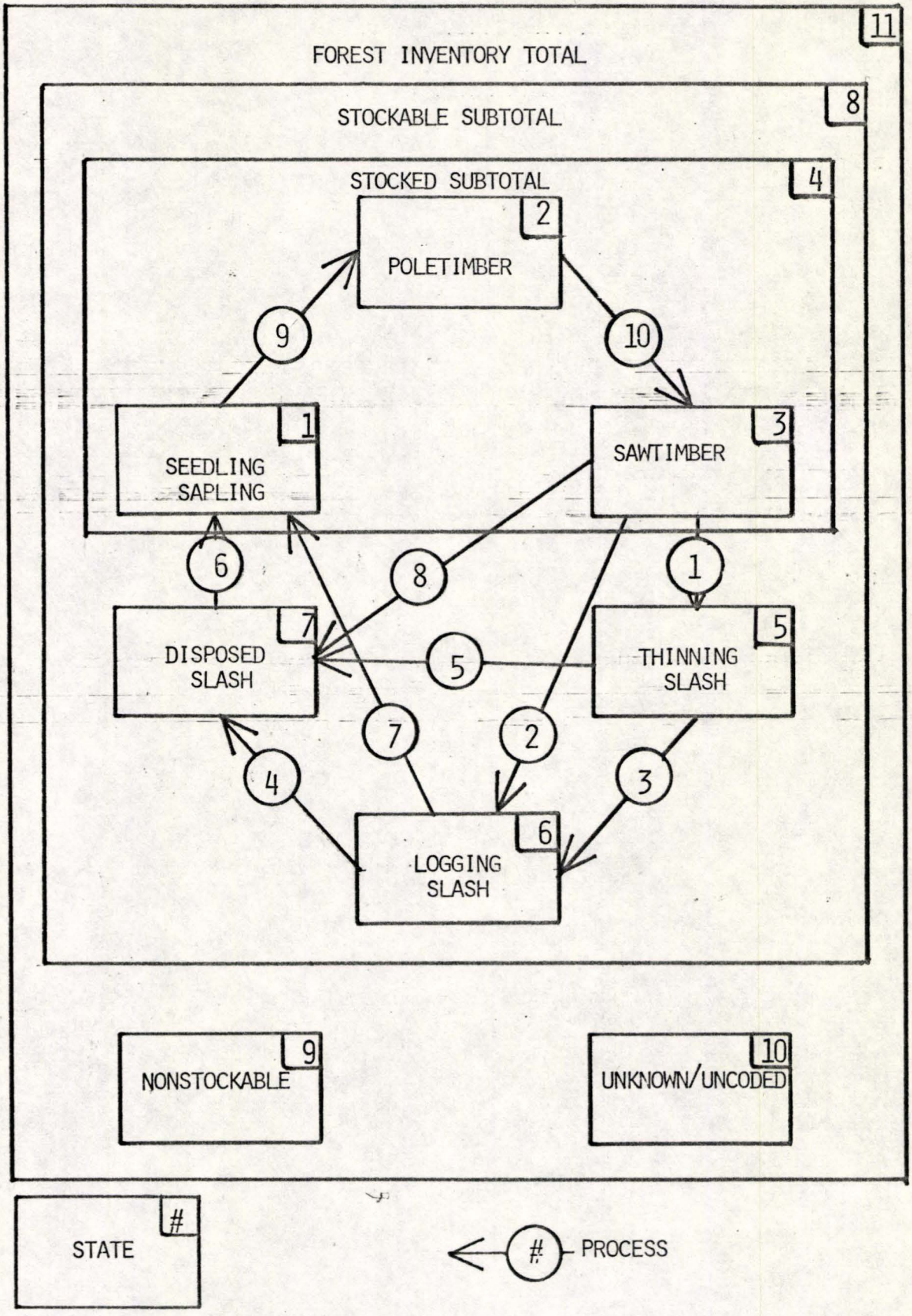


Figure 2. (continued)

Vector	Description (reference FSH 2409.21e R1)
1	Thinning - precommercial or commercial thinnings
2	Harvest (without previous thinning) - includes clearcut, shelterwood cut, seed tree cut, overstory removal, rehabilitation cut, selection cut, and salvage cut. Excludes intermediate cuts, fire, and 'other' harvests.
3	Harvest following thinning - same as Vector 2 above
4	Slash disposal (following harvest) - includes prescribed burn, dozer pile, dozer terrace, hand pile, herbicide spray and burn, machine scarify, machine terrace, machine furrowing and discing, and wildfire. Excludes lopping, jackpot burn, supplemental protection, rolling chopper, trampling, herbicide spray, and 'other'.
5	Slash disposal (following thinning and before harvest) - same as Vector 4
6	Regeneration following slash disposal
7	Regeneration without previous slash disposal
8	Wildfire - assumed to have occurred in a mature sawtimber stand since it is coded as a 'harvest or other drain'.
9	Stand growth - assumes 50 years to progress from established regeneration to poletimber.
10	Stand growth - assumes 40 years to progress from poletimber to sawtimber

C. Elevation Band Stratification Analysis

The 1960 decade 5100-29 forms coded fire origin elevation with single digit codes corresponding to even 1000 foot intervals (e.g., 1 = 1000 to 1999 feet, 2 = 2000 to 2999 feet, etc.). The 1970 decade 5100-29 forms, on the other hand, recorded elevation with single digit codes corresponding to offset 1000 ft intervals (e.g., 2 = 1501 to 2500 feet, 3 = 2501 to 3500 feet, etc.). It was therefore impossible to reconcile the codes between the two decades. All 1970 decade fire elevations were therefore hand-coded from the original forms to comply with the 1960's code scheme. The FINSYS forest inventory database records elevation to the nearest 100 foot contour.

D. Computation of Fire Variables

Lightning fire occurrence and acres burned from 1960 through 1978 were tabulated from the Northern Region 5100-29 Individual Fire Report data tapes. USDA Forest Service acreages were determined using the FINSYS database TABLES and OUTPUT routines. Both routines are standard computer software packages used by Timber Management in TM planning. The Northern Region Stand Examination and Management Status Record master tape was also used to compute yearly acreages by stand condition class.

Only lightning fires starting on USDA Forest Service lands were included in the fire start and acres burned tally. Fires starting within areas not sampled by the forest inventory procedure (e.g., existing wilderness areas) were excluded from the analysis.

Lightning fire densities were computed using the formula:

$D_{ij} = 1{,}000{,}000 \times F_{ij} / (A_{ij} \times Y)$, where

D_{ij} = fires per million acres per year in class j of stratification i,

F_{ij} = total number of lightning fires in class j of stratification i during the study period,

A_{ij} = mean number of acres in class j of stratification i during the study period, and

Y = number of years in the study period.

Percent area burned per annum was determined by:

$P_{ij} = 100 \times B_{ij} / (A_{ij} \times Y)$, where

P_{ij} = percent of class j area burned per annum, and

B_{ij} = total acres burned within class j of stratification i during the study period.

The 'burnover rate' was computed assuming lightning fires burn randomly within each stratification class, and that the fire regime over the 19 year study period may be projected into the indefinite future:

$R_{ij} = (P_{ij} / 100)^{-1}$, where

R_{ij} = burnover rate (years to burn over completely one time) for class j of stratification i.

IV. RESULTS

Study results are presented in the following 30 tables. Tables F05.1.1 through F05.3.5 present fire density results for the Clearwater National Forest, and tables F09.1.1 through F09.3.5 present Deerlodge National Forest results.

The following scheme was used to identify the tables:

Faa.b.c, where

aa = Northern Region national forest ADP code

- 05 = Clearwater National Forest
- 09 = Deerlodge National Forest

b = stratification scheme

- 1 = forest cover type
- 2 = stand condition class
- 3 = elevation band

c = fire analysis variable

- 1 = USDA Forest Service acreages
- 2 = lightning fire occurrence
- 3 = lightning fire per million acres per year
- 4 = lightning fire acres burned
- 5 = percent area burned per annum

TABLE F05.1.1

CLEARWATER NATIONAL FOREST

USDA FOREST INVENTORY ACREAGES BY FOREST COVER TYPE

1960 THRO 1978

FOREST COVER TYPE	ANNUAL MEAN	ANNUAL ST DEV	PERCENT ST DEV	CLASS PERCENT
DOUGLAS-FIR	339466.	29084.	9.	20.
WL-DF (-PP)	19276.	5788.	30.	1.
GF-WL-DF	276633.	27596.	10.	17.
PONDEROSA	738.	399.	54.	0.
WHITE PINE	29147.	6826.	23.	2.
LODGEPOLE	262716.	20528.	8.	16.
SPRUCE	56046.	9475.	17.	3.
WRC, WH	185625.	19037.	10.	11.
SUBALPINE	264860.	0.	0.	16.
HARDWOODS	10715.	5814.	54.	1.
OTHER STKBLE	0.	0.	0.	0.
STKBLE SUBTL	1445221.	33809.	2.	86.
NONSTOCKABLE	230167.	20103.	9.	14.
UNKNOWN	0.	0.	0.	0.
INVENTY TOTL	1675388.	39317.	2.	100.

TABLE F05.1.2

CLEARWATER NATIONAL FOREST

LIGHTNING FIRE OCCURRENCE BY FOREST COVER TYPE

1960 THRO 1978

FOREST COVER TYPE	ANNUAL MEAN	ANNUAL ST DEV	ANNUAL MEDIAN	PERIOD TOTALS
DOUGLAS-FIR	6.	6.	4.	116.
WL-DF (-PP)	6.	5.	4.	115.
GF-WL-DF	20.	13.	15.	379.
PONDEROSA	1.	1.	0.	18.
WHITE PINE	9.	8.	6.	171.
LODGEPOLE	5.	7.	3.	102.
SPRUCE	6.	5.	3.	110.
WRC, WH	16.	7.	14.	298.
SUBALPINE	7.	8.	6.	137.
HARDWOODS	0.	0.	0.	0.
OTHER STKBLE	0.	0.	0.	0.
STKBLE SUBTL	76.	48.	62.	1446.
NONSTOCKABLE	8.	6.	8.	154.
UNKNOWN	0.	0.	0.	0.
INVENTY TOTL	84.	53.	73.	1600.

TABLE F05.1.3

CLEARWATER NATIONAL FOREST

LIGHTNING FIRES/MM ACRES/YEAR BY FOREST COVER TYPE

1960 THRO 1978

FOREST COVER TYPE	ANNUAL MEAN	ANNUAL ST DEV	ANNUAL MEDIAN	RELATIVE RATING
DOUGLAS-FIR	18.	17.	12.	1.
WL-DF (-PP)	314.	235.	208.	24.
GF-WL-DF	72.	47.	54.	6.
PONDEROSA	1284.	1833.	0.	100.
WHITE PINE	309.	268.	206.	24.
LODGEPOLE	20.	26.	11.	2.
SPRUCE	103.	96.	54.	8.
WRC, WH	84.	40.	75.	7.
SUBALPINE	27.	29.	23.	2.
HARDWOODS	0.	0.	0.	0.
OTHER STKBLE	0.	0.	0.	0.
STKBLE SUBTL	53.	33.	43.	4.
NONSTOCKABLE	35.	26.	35.	3.
UNKNOWN	0.	0.	0.	0.
INVENTY TOTL	50.	32.	44.	4.

TABLE F05.1.4

CLEARWATER NATIONAL FOREST

LIGHTNING FIRE ACRES BURNED BY FOREST COVER TYPE

1960 THRO 1978

FOREST COVER TYPE	ANNUAL MEAN	ANNUAL ST DEV	ANNUAL MEDIAN	PERIOD TOTALS
DOUGLAS-FIR	3.	3.	2.	62.
WL-DF (-PP)	13.	35.	2.	245.
GF-WL-DF	14.	14.	7.	266.
PONDEROSA	1.	2.	0.	18.
WHITE PINE	47.	118.	4.	894.
LODGEPOLE	22.	76.	2.	427.
SPRUCE	269.	1148.	1.	5106.
WRC, WH	17.	22.	10.	317.
SUBALPINE	8.	17.	2.	156.
HARDWOODS	0.	0.	0.	0.
OTHER STKBLE	0.	0.	0.	0.
STKBLE SUBTL	393.	1266.	50.	7475.
NONSTOCKABLE	6.	9.	2.	108.
UNKNOWN	0.	0.	0.	0.
INVENTY TOTL	399.	1267.	52.	7584.

TABLE F05.1.5

CLEARWATER NATIONAL FOREST

PERCENT AREA BURNED PER ANNUM BY FOREST COVER TYPE

1960 THRO 1978

FOREST COVER TYPE	ANNUAL MEAN	ANNUAL ST DEV	ANNUAL MEDIAN	BURNOVER RATE YRS
DOUGLAS-FIR	.0010	.0009	.0006	104019.
WL-DF (-PP)	.0669	.1821	.0104	1495.
GF-WL-DF	.0051	.0051	.0025	19759.
PONDEROSA	.1284	.2324	.0000	779.
WHITE PINE	.1614	.4045	.0137	619.
LODGEPOLE	.0086	.0290	.0008	11690.
SPRUCE	.4795	2.0491	.0018	209.
WRC, WH	.0090	.0119	.0054	11126.
SUBALPINE	.0031	.0065	.0008	32258.
HARDWOODS	.0000	.0001	.0000	0.
OTHER STKBLE	.0000	.0001	.0000	0.
STKBLE SUBTL	.0272	.0876	.0035	3673.
NONSTOCKABLE	.0025	.0039	.0009	40491.
UNKNOWN	.0000	.0001	.0000	0.
INVENTY TOTL	.0238	.0756	.0031	4197.

TABLE F05.2.1

CLEARWATER NATIONAL FOREST

USDA FOREST INVENTORY ACREAGES BY STAND MGMT STATUS

1960 THRO 1978

STAND MGMT STATUS	ANNUAL MEAN	ANNUAL ST DEV	PERCENT ST DEV	CLASS PERCENT
SEED/SAPLING	222638.	13779.	6.	13.
POLETIMBER	200511.	3292.	2.	12.
SAWTIMBER	987491.	9304.	1.	59.
STOCKED TOTL	1410640.	22935.	2.	84.
THINNG SLASH	3596.	3907.	109.	0.
LOGGNG SLASH	21984.	12659.	58.	1.
DISPSD SLASH	10279.	6627.	64.	1.
STKABLE TOTL	1446499.	0.	0.	86.
NONSTOCKABLE	228889.	0.	0.	14.
UNKNOWN	0.	0.	0.	0.
INVENTY TOTL	1675388.	0.	0.	100.

TABLE F05.2.2

CLEARWATER NATIONAL FOREST

LIGHTNING FIRE OCCURRENCE BY STAND MGMT STATUS

1960 THRO 1978

STAND MGMT STATUS	ANNUAL MEAN	ANNUAL ST DEV	ANNUAL MEDIAN	PERIOD TOTALS
SEED/SAPLING	3.	5.	2.	06.
POLETIMBER	7.	7.	5.	125.
SAWTIMBER	56.	33.	43.	1060.
STOCKED TOTL	66.	40.	53.	1251.
THINNG SLASH	0.	0.	0.	4.
LOGGNG SLASH	4.	4.	3.	71.
DISPSD SLASH	6.	6.	5.	119.
STKABLE TOTL	76.	48.	62.	1445.
NONSTOCKABLE	8.	6.	8.	154.
UNKNOWN	0.	0.	0.	1.
INVENTY TOTL	84.	53.	73.	1600.

TABLE F05.2.3

CLEARWATER NATIONAL FOREST

LIGHTNING FIRES/MM ACRES/YEAR BY STAND MGMT STATUS

1960 THRO 1978

STAND MGMT STATUS	ANNUAL MEAN	ANNUAL ST DEV	ANNUAL MEDIAN	RELATIVE RATING
SEED/SAPLING	15.	21.	9.	1.
POLETIMBER	33.	32.	25.	3.
SAWTIMBER	56.	34.	43.	5.
STOCKED TOTL	47.	28.	37.	5.
THINNG SLASH	969.	2671.	0.	94.
LOGGNG SLASH	219.	216.	157.	21.
DISPSD SLASH	1031.	1077.	399.	100.
STKABLE TOTL	53.	33.	43.	5.
NONSTOCKABLE	35.	26.	35.	3.
UNKNOWN	0.	0.	0.	0.
INVENTY TOTL	50.	32.	44.	5.

TABLE F05.2.4

CLEARWATER NATIONAL FOREST

LIGHTNING FIRE ACRES BURNED BY STAND MGMT STATUS

1960 THRO 1978

STAND MGMT STATUS	ANNUAL MEAN	ANNUAL ST DEV	ANNUAL MEDIAN	PERIOD TOTALS
SEED/SAPLING	3.	8.	1.	62.
POLETIMBER	23.	75.	1.	443.
SAWTIMBER	356.	1251.	32.	6756.
STOCKED TOTL	382.	1268.	37.	7201.
THINNG SLASH	0.	0.	0.	0.
LOGGNG SLASH	8.	15.	3.	151.
DISPSD SLASH	4.	4.	2.	69.
STKABLE TOTL	393.	1266.	50.	7475.
NONSTOCKABLE	6.	9.	2.	108.
UNKNOWN	0.	0.	0.	0.
INVENTY TOTL	399.	1267.	52.	7584.

TABLE F05.2.5

CLEARWATER NATIONAL FOREST

PERCENT AREA BURNED PER ANNUM BY STAND MGMT STATUS

1960 THRO 1978

STAND MGMT STATUS	ANNUAL MEAN	ANNUAL ST DEV	ANNUAL MEDIAN	BURNOVER RATE YRS
SEED/SAPLING	.0014	.0033	.0004	71772.
POLETIMBER	.0115	.0369	.0005	8686.
SAWTIMBER	.0360	.1268	.0032	2779.
STOCKED TOTL	.0267	.0882	.0026	3751.
THINNG SLASH	.0000	.0001	.0000	0.
LOGGNG SLASH	.0418	.0648	.0147	2390.
DISPSD SLASH	.0542	.0677	.0192	1845.
STKABLE TOTL	.0272	.0875	.0035	3677.
NONSTOCKABLE	.0025	.0039	.0009	40266.
UNKNOWN	.0000	.0001	.0000	0.
INVENTY TOTL	.0238	.0756	.0031	4197.

TABLE F05.3.1

CLEARWATER NATIONAL FOREST

USDA FOREST INVENTORY ACREAGES BY ELEVATION CLASS

1960 THRO 1978

ELEVATION CLASS	ANNUAL MEAN	ANNUAL ST DEV	PERCENT ST DEV	CLASS PERCENT
1000-1999 FT	20914.	5657.	27.	1.
2000-2999 FT	60993.	11751.	19.	4.
3000-3999 FT	287895.	26599.	9.	17.
4000-4999 FT	565145.	36338.	6.	34.
5000-5999 FT	492007.	28938.	6.	29.
6000-6999 FT	241868.	27897.	12.	14.
7000-7999 FT	0.	0.	0.	0.
8000-8999 FT	0.	0.	0.	0.
9000 FT PLUS	0.	0.	0.	0.
SUBTOTAL	1668822.	39317.	2.	100.
UNKNOWN	6566.	0.	0.	0.
INVENTY TOTL	1675388.	39317.	2.	100.

TABLE F05.3.2

CLEARWATER NATIONAL FOREST

LIGHTNING FIRE OCCURRENCE BY ELEVATION CLASS

1960 THRO 1978

ELEVATION CLASS	ANNUAL MEAN	ANNUAL ST DEV	ANNUAL MEDIAN	PERIOD TOTALS
1000-1999 FT	0.	0.	0.	2.
2000-2999 FT	2.	2.	1.	34.
3000-3999 FT	10.	6.	8.	195.
4000-4999 FT	27.	18.	19.	507.
5000-5999 FT	27.	19.	19.	515.
6000-6999 FT	15.	11.	13.	290.
7000-7999 FT	3.	3.	2.	53.
8000-8999 FT	0.	1.	0.	4.
9000 FT PLUS	0.	0.	0.	0.
SUBTOTAL	84.	53.	73.	1600.
UNKNOWN	0.	0.	0.	0.
INVENTY TOTL	84.	53.	73.	1600.

TABLE F05.3.3

CLEARWATER NATIONAL FOREST

LIGHTNING FIRES/MM ACRES/YEAR BY ELEVATION CLASS

1960 THRO 1978

ELEVATION CLASS	ANNUAL MEAN	ANNUAL ST DEV	ANNUAL MEDIAN	RELATIVE RATING
1000-1999 FT	5.	15.	0.	8.
2000-2999 FT	29.	33.	16.	46.
3000-3999 FT	36.	22.	28.	56.
4000-4999 FT	47.	33.	34.	75.
5000-5999 FT	55.	39.	39.	87.
6000-6999 FT	63.	46.	54.	100.
7000-7999 FT	0.	0.	0.	0.
8000-8999 FT	0.	0.	0.	0.
9000 FT PLUS	0.	0.	0.	0.
SUBTOTAL	50.	32.	44.	80.
UNKNOWN	0.	0.	0.	0.
INVENTY TOTL	50.	32.	44.	80.

TABLE F05.3.4

CLEARWATER NATIONAL FOREST

LIGHTNING FIRE ACRES BURNED BY ELEVATION CLASS

1960 THRO 1978

ELEVATION CLASS	ANNUAL MEAN	ANNUAL ST DEV	ANNUAL MEDIAN	PERIOD TOTALS
1000-1999 FT	0.	0.	0.	0.
2000-2999 FT	3.	7.	1.	57.
3000-3999 FT	30.	90.	3.	567.
4000-4999 FT	85.	265.	10.	1611.
5000-5999 FT	241.	894.	18.	4568.
6000-6999 FT	39.	106.	8.	741.
7000-7999 FT	1.	2.	1.	25.
8000-8999 FT	0.	1.	0.	8.
9000 FT PLUS	0.	0.	0.	0.
SUBTOTAL	399.	1267.	52.	7584.
UNKNOWN	0.	0.	0.	0.
INVENTY TOTL	399.	1267.	52.	7584.

TABLE F05.3.5

CLEARWATER NATIONAL FOREST

PERCENT AREA BURNED PER ANNUM BY ELEVATION CLASS

1960 THRO 1978

ELEVATION CLASS	ANNUAL MEAN	ANNUAL ST DEV	ANNUAL MEDIAN	BURNOVER RATE YRS
1000-1999 FT	.0000	.0001	.0000	0.
2000-2999 FT	.0049	.0122	.0016	20331.
3000-3999 FT	.0104	.0311	.0010	9647.
4000-4999 FT	.0150	.0470	.0018	6665.
5000-5999 FT	.0491	.1818	.0037	2038.
6000-6999 FT	.0161	.0438	.0033	6202.
7000-7999 FT	.0000	.0001	.0000	0.
8000-8999 FT	.0000	.0001	.0000	0.
9000 FT PLUS	.0000	.0001	.0000	0.
SUBTOTAL	.0239	.0759	.0031	4181.
UNKNOWN	.0000	.0001	.0000	0.
INVENTY TOTL	.0238	.0756	.0031	4197.

TABLE F09.1.1

DEERLODGE NATIONAL FOREST

USDA FOREST INVENTORY ACREAGES BY FOREST COVER TYPE

1960 THRO 1978

FOREST COVER TYPE	ANNUAL MEAN	ANNUAL ST DEV	PERCENT ST DEV	CLASS PERCENT
DF, DF-LL	352225.	15659.	4.	29.
WL-DF (-PP)	0.	0.	0.	0.
GF-WL-DF	0.	0.	0.	0.
PONDEROSA	0.	0.	0.	0.
WHITE PINE	0.	0.	0.	0.
LODGEPOLE	406759.	12042.	3.	34.
SPRUCE	4432.	1344.	30.	0.
WRC, WH	0.	0.	0.	0.
SUBALPINE	149075.	12654.	8.	12.
HARDWOODS	0.	0.	0.	0.
OTHER STKBLE	0.	0.	0.	0.
STKBLE SUBTL	912491.	5.	0.	76.
NONSTOCKABLE	295798.	4.	0.	24.
UNKNOWN	0.	0.	0.	0.
INVENTY TOTL	1208289.	5.	0.	100.

TABLE F09.1.2

DEERLODGE NATIONAL FOREST

LIGHTNING FIRE OCCURRENCE BY FOREST COVER TYPE

1960 THRO 1978

FOREST COVER TYPE	ANNUAL MEAN	ANNUAL ST DEV	ANNUAL MEDIAN	PERIOD TOTALS
DF, DF-LL	9.	6.	9.	176.
WL-DF (-PP)	0.	0.	0.	1.
GF-WL-DF	0.	0.	0.	0.
PONDEROSA	0.	1.	0.	6.
WHITE PINE	0.	0.	0.	0.
LODGEPOLE	8.	6.	6.	146.
SPRUCE	0.	0.	0.	3.
WRC, WH	0.	0.	0.	0.
SUBALPINE	1.	1.	1.	20.
HARDWOODS	0.	0.	0.	0.
OTHER STKBLE	0.	0.	0.	0.
STKBLE SUBTL	19.	12.	15.	352.
NONSTOCKABLE	1.	1.	1.	10.
UNKNOWN	0.	0.	0.	0.
INVENTY TOTL	19.	12.	16.	362.

TABLE F09.1.3

DEERLODGE NATIONAL FOREST

LIGHTNING FIRES/MM ACRES/YEAR BY FOREST COVER TYPE

1960 THRO 1978

FOREST COVER TYPE	ANNUAL MEAN	ANNUAL ST DEV	ANNUAL MEDIAN	RELATIVE RATING
DF, DF-LL	26.	16.	26.	74.
WL-DF (-PP)	0.	0.	0.	0.
GF-WL-DF	0.	0.	0.	0.
PONDEROSA	0.	0.	0.	0.
WHITE PINE	0.	0.	0.	0.
LODGEPOLE	19.	14.	15.	53.
SPRUCE	36.	85.	0.	100.
WRC, WH	0.	0.	0.	0.
SUBALPINE	7.	10.	7.	20.
HARDWOODS	0.	0.	0.	0.
OTHER STKBLE	0.	0.	0.	0.
STKBLE SUBTL	20.	13.	16.	57.
NONSTOCKABLE	2.	2.	3.	5.
UNKNOWN	0.	0.	0.	0.
INVENTY TOTL	16.	10.	13.	44.

TABLE F09.1.4

DEERLODGE NATIONAL FOREST

LIGHTNING FIRE ACRES BURNED BY FOREST COVER TYPE

1960 THRO 1978

FOREST COVER TYPE	ANNUAL MEAN	ANNUAL ST DEV	ANNUAL MEDIAN	PERIOD TOTALS
DF, DF-LP	5.	9.	0.	88.
WL-DF (-PP)	0.	0.	0.	0.
GF-WL-DF	0.	0.	0.	0.
PONDEROSA	0.	0.	0.	2.
WHITE PINE	0.	0.	0.	0.
LODGEPOLE	16.	25.	7.	302.
SPRUCE	0.	0.	0.	0.
WRC, WH	0.	0.	0.	0.
SUBALPINE	4.	15.	0.	70.
HARDWOODS	0.	0.	0.	0.
OTHER STKBLE	0.	0.	0.	0.
STKBLE SUBTL	24.	31.	14.	462.
NONSTOCKABLE	1.	2.	0.	16.
UNKNOWN	0.	0.	0.	0.
INVENTY TOTL	25.	32.	18.	478.

TABLE F09.1.5

DEERLODGE NATIONAL FOREST

PERCENT AREA BURNED PER ANNUM BY FOREST COVER TYPE

1960 THRO 1978

FOREST COVER TYPE	ANNUAL MEAN	ANNUAL ST DEV	ANNUAL MEDIAN	BURNOVER RATE YRS
DF, DF-LM	.0013	.0026	.0000	76043.
WL-DF (-PP)	.0000	.0001	.0000	0.
GF-WL-DF	.0000	.0001	.0000	0.
PONDEROSA	.0000	.0001	.0000	0.
WHITE PINE	.0000	.0001	.0000	0.
LODGEPOLE	.0039	.0061	.0017	25590.
SPRUCE	.0000	.0001	.0000	0.
WRC, WH	.0000	.0001	.0000	0.
SUBALPINE	.0025	.0100	.0000	40462.
HARDWOODS	.0000	.0001	.0000	0.
OTHER STKBLE	.0000	.0001	.0000	0.
STKBLE SUBTL	.0027	.0034	.0015	37525.
NONSTOCKABLE	.0003	.0006	.0000	351137.
UNKNOWN	.0000	.0001	.0000	0.
INVENTY TOTL	.0021	.0026	.0015	48026.

TABLE F09.2.1

DEERLODGE NATIONAL FOREST

USDA FOREST INVENTORY ACREAGES BY STAND MGMT STATUS

1960 THRO 1978

STAND MGMT STATUS	ANNUAL MEAN	ANNUAL ST DEV	PERCENT ST DEV	CLASS PERCENT
SEED/SAPLING	45523.	2819.	6.	4.
POLETIMBER	168397.	18883.	11.	14.
SAWTIMBER	683222.	8102.	1.	57.
STOCKED TOTL	897143.	10405.	1.	74.
THINNG SLASH	1414.	1454.	103.	0.
LOGGNG SLASH	5050.	2967.	59.	0.
DISPSD SLASH	8884.	7041.	79.	1.
STKABLE TOTL	912491.	0.	0.	76.
NONSTOCKABLE	295798.	0.	0.	24.
UNKNOWN	0.	0.	0.	0.
INVENTY TOTL	1208289.	0.	0.	100.

TABLE F09.2.2

DEERLODGE NATIONAL FOREST

LIGHTNING FIRE OCCURRENCE BY STAND MGMT STATUS

1960 THRO 1978

STAND MGMT STATUS	ANNUAL MEAN	ANNUAL ST DEV	ANNUAL MEDIAN	PERIOD TOTALS
SEED/SAPLING	0.	1.	0.	5.
POLETIMBER	2.	2.	1.	39.
SAWTIMBER	14.	10.	10.	270.
STOCKED TOTL	17.	11.	11.	314.
THINNG SLASH	0.	0.	0.	1.
LOGGNG SLASH	1.	1.	0.	12. 7
DISPSD SLASH	1.	2.	1.	25. 6
STKABLE TOTL	19.	12.	15.	352.
NONSTOCKABLE	1.	1.	1.	10.
UNKNOWN	0.	0.	0.	0.
INVENTY TOTL	19.	12.	16.	362.

TABLE F09.2.3

DEERLODGE NATIONAL FOREST

LIGHTNING FIRES/MM ACRES/YEAR BY STAND MGMT STATUS

1960 THRO 1978

STAND MGMT STATUS	ANNUAL MEAN	ANNUAL ST DEV	ANNUAL MEDIAN	RELATIVE RATING
SEED/SAPLING	6.	13.	0.	1.
POLETIMBER	12.	13.	7.	3.
SAWTIMBER	21.	14.	15.	5.
STOCKED TOTL	18.	12.	12.	5.
THINNG SLASH	291.	1267.	0.	72.
LOGGNG SLASH	114.	182.	0.	28.
DISPSD SLASH	402.	740.	91.	100.
STKABLE TOTL	20.	13.	16.	5.
NONSTOCKABLE	2.	2.	3.	0.
UNKNOWN	0.	0.	0.	0.
INVENTY TOTL	16.	10.	13.	4.

TABLE F09.2.4

DEERLODGE NATIONAL FOREST

LIGHTNING FIRE ACRES BURNED BY STAND MGMT STATUS

1960 THRO 1978

STAND MGMT STATUS	ANNUAL MEAN	ANNUAL ST DEV	ANNUAL MEDIAN	PERIOD TOTALS
SEED/SAPLING	0.	1.	0.	6.
POLETIMBER	6.	17.	0.	107.
SAWTIMBER	17.	23.	8.	316.
STOCKED TOTL	23.	30.	9.	429.
THINNG SLASH	0.	0.	0.	0.
LOGGNG SLASH	1.	3.	0.	17.
DISPSD SLASH	1.	2.	0.	16.
STKABLE TOTL	24.	31.	14.	462.
NONSTOCKABLE	1.	2.	0.	16.
UNKNOWN	0.	0.	0.	0.
INVENTY TOTL	25.	32.	18.	478.

TABLE F09.2.5

DEERLODGE NATIONAL FOREST

PERCENT AREA BURNED PER ANNUM BY STAND MGMT STATUS

1960 THRO 1978

STAND MGMT STATUS	ANNUAL MEAN	ANNUAL ST DEV	ANNUAL MEDIAN	BURNOVER RATE YRS
SEED/SAPLING	.0007	.0024	.0000	149343.
POLETIMBER	.0030	.0089	.0000	33174.
SAWTIMBER	.0024	.0034	.0012	40851.
STOCKED TOTL	.0025	.0033	.0010	39951.
THINNG SLASH	.0000	.0001	.0000	0.
LOGGNG SLASH	.0242	.0825	.0000	4130.
DISPSD SLASH	.0274	.0788	.0000	3655.
STKABLE TOTL	.0027	.0034	.0015	37525.
NONSTOCKABLE	.0003	.0006	.0000	351137.
UNKNOWN	.0000	.0001	.0000	0.
INVENTY TOTL	.0021	.0026	.0015	48026.

TABLE F09.3.1

DEERLODGE NATIONAL FOREST

USDA FOREST INVENTORY ACREAGES BY ELEVATION CLASS

1960 THRU 1978

ELEVATION CLASS	ANNUAL MEAN	ANNUAL ST DEV	PERCENT ST DEV	CLASS PERCENT
1000-1999 FT	0.	0.	0.	0.
2000-2999 FT	0.	0.	0.	0.
3000-3999 FT	0.	0.	0.	0.
4000-4999 FT	73433.	21101.	29.	6.
5000-5999 FT	75630.	9095.	12.	6.
6000-6999 FT	580364.	23257.	4.	48.
7000-7999 FT	406602.	20367.	5.	34.
8000-8999 FT	66586.	10832.	16.	6.
9000 FT PLUS	0.	0.	0.	0.
SUBTOTAL	1202616.	7.	0.	100.
UNKNOWN	5673.	0.	0.	0.
INVENTY TOTL	1208289.	7.	0.	100.

TABLE F09.3.2

DEERLODGE NATIONAL FOREST

LIGHTNING FIRE OCCURRENCE BY ELEVATION CLASS

1960 THRO 1978

ELEVATION CLASS	ANNUAL MEAN	ANNUAL ST DEV	ANNUAL MEDIAN	PERIOD TOTALS
1000-1999 FT	0.	0.	0.	0.
2000-2999 FT	0.	0.	0.	0.
3000-3999 FT	0.	0.	0.	0.
4000-4999 FT	0.	0.	0.	0.
5000-5999 FT	3.	2.	3.	62.
6000-6999 FT	9.	6.	8.	163.
7000-7999 FT	6.	4.	5.	105.
8000-8999 FT	1.	1.	1.	27.
9000 FT PLUS	0.	0.	0.	5.
SUBTOTALI	19.	12.	16.	362.
UNKNOWN	0.	0.	0.	0.
INVENTY TOTL	19.	12.	16.	362.

TABLE F09.3.3

DEERLODGE NATIONAL FOREST

LIGHTNING FIRES/MM ACRES/YEAR BY ELEVATION CLASS

1960 THRO 1978

ELEVATION CLASS	ANNUAL MEAN	ANNUAL ST DEV	ANNUAL MEDIAN	RELATIVE RATING
1000-1999 FT	0.	0.	0.	0.
2000-2999 FT	0.	0.	0.	0.
3000-3999 FT	0.	0.	0.	0.
4000-4999 FT	0.	0.	0.	0.
5000-5999 FT	43.	32.	40.	100.
6000-6999 FT	15.	10.	14.	34.
7000-7999 FT	14.	10.	12.	32.
8000-8999 FT	21.	21.	15.	49.
9000 FT PLUS	0.	0.	0.	0.
SUBTOTAL	16.	10.	13.	37.
UNKNOWN	0.	0.	0.	0.
INVENTY TOTL	16.	10.	13.	37.

TABLE F09.3.4

DEERLODGE NATIONAL FOREST

LIGHTNING FIRE ACRES BURNED BY ELEVATION CLASS

1960 THRO 1978

ELEVATION CLASS	ANNUAL MEAN	ANNUAL ST DEV	ANNUAL MEDIAN	PERIOD TOTALS
1000-1999 FT	0.	0.	0.	0.
2000-2999 FT	0.	0.	0.	0.
3000-3999 FT	0.	0.	0.	0.
4000-4999 FT	0.	0.	0.	0.
5000-5999 FT	2.	5.	0.	38.
6000-6999 FT	10.	20.	3.	186.
7000-7999 FT	9.	16.	3.	174.
8000-8999 FT	4.	14.	0.	75.
9000 FT PLUS	0.	1.	0.	5.
SUBTOTAL	25.	32.	18.	478.
UNKNOWN	0.	0.	0.	0.
INVENTY TOTL	25.	32.	18.	478.

TABLE F09.3.5

DEERLODGE NATIONAL FOREST

PERCENT AREA BURNED PER ANNUM BY ELEVATION CLASS

1960 THRO 1978

ELEVATION CLASS	ANNUAL MEAN	ANNUAL ST DEV	ANNUAL MEDIAN	BURNOVER RATE YRS
1000-1999 FT	.0000	.0001	.0000	0.
2000-2999 FT	.0000	.0001	.0000	0.
3000-3999 FT	.0000	.0001	.0000	0.
4000-4999 FT	.0000	.0001	.0000	0.
5000-5999 FT	.0026	.0064	.0000	37814.
6000-6999 FT	.0017	.0035	.0005	59281.
7000-7999 FT	.0023	.0038	.0007	44397.
8000-8999 FT	.0059	.0206	.0000	16868.
9000 FT PLUS	.0000	.0001	.0000	0.
SUBTOTALS	.0021	.0026	.0015	47800.
UNKNOWN	.0000	.0001	.0000	0.
INVENTY TOTL	.0021	.0026	.0015	48026.

V. DISCUSSION

A. National Forest

The Clearwater National Forest reported 1600 lightning fires starting on 1,675,388 nonwilderness acres of Forest Service administered lands from 1960 through 1978, resulting in an annual fire density of 50 per million acres. Total lightning fire acres burned during the period was 7,584 for a mean percent area burned per annum of 0.02%. This translates to a burnover rate of 4200 years for the entire forest, and 3670 years for stockable timberlands. The burnover rate is several orders of magnitude longer than the 10 to 100 year mean fire free interval reported by Arno (1976) as the natural fire regime for the neighboring Bitterroot National Forest.

The Deerlodge National Forest reported 362 lightning fires starting on 1,208,289 nonwilderness acres for an annual fire density of 16 fires per million acres. The fires burned a total land area of 478 acres for a mean percent area burned per annum of 0.002%. The percent burned per annum for the Deerlodge NF is a factor of 10 smaller than that for the Clearwater NF. The Deerlodge NF burnover rate is about 48,000 years for the entire forest, and approximately 37,500 years on stockable timberlands.

B. Forest Cover Types

Ponderosa pine cover types have the highest mean lightning fire density on the Clearwater National Forest (1284 fires/mm ac/yr) followed by western larch - Douglas-fir (314), western white pine (309), and spruce (103) cover types. Douglas-fir (18 fires/mm ac/yr) and lodgepole pine (20) have the lowest densities. The Deerlodge National Forest results showed similar trends. Spruce has the highest lightning fire density (36), and lodgepole pine and Douglas-fir have the lowest (19 and 26 fires/mm ac/yr, respectively). The Deerlodge NF reported no acreages or fires for ponderosa pine, western larch - Douglas-fir, or western white pine cover types.

The cover type rankings by lightning fire density for the Clearwater and Deerlodge National Forests is very similar to that reported by the investigator for the Lolo[1/] and Kootenai[2/] National Forests; ponderosa pine, western larch - Douglas-fir, western white pine, and spruce have the highest lightning fire densities, and Douglas-fir and lodgepole pine have the lowest. An order of magnitude difference in lightning fire density is common between the high and low groups.

Ponderosa pine cover types on the Clearwater National Forest have an average percent area burned per annum of 0.13% for a burnover rate of 780 years. This is again an order of magnitude longer than that reported by Arno (1976) as the natural mean fire free interval for ponderosa pine habitat types on the neighboring Bitterroot National Forest.

C. Stand Condition

Results from both the Clearwater and Deerlodge National Forests show a pronounced increase in lightning fire density as stands progress through a typical rotation. Densities are lowest for seedling-sapling stands, and increase for poletimber and mature sawtimber stands. Lightning fire density then increases by a factor of 5 when sawtimber is harvested, converting the site to logging slash. The density is increased even more dramatically when logging slash is disposed. The increase in fire density from sawtimber to logging slash to disposed slash for the Clearwater NF is 56 to 219 to 1031 fires per million acres per year. The same progression for the Deerlodge National Forest is 21 to 114 to 402 fires/mm ac/year.

The forest management cycle model used to determine yearly logging slash, thinning slash, and disposed slash acres considered a stand to be 'disposed slash' only if the slash disposal or site preparation method employed involved fuel bed modification throughout the entire stand. Such methods generally involve burning or scarification and piling, and therefore replaces the dense, compacted slash with light, fluffy annuals and perennials. The latter are easier to ignite, dry more rapidly after wetting, and permit faster fire spread than do slash fuels. It therefore appears that slash disposal practices may actually contribute to stand fire hazard.

Mean lightning fire sizes may be determined for the stand condition classes from the tables of results. Mean lightning fire sizes for Clearwater NF sawtimber, logging slash, and disposed slash sites are 6.4, 2.1, and 0.6 acres per fire, respectively. Mean lightning fire

size on the Deerlodge is 1.2 acres in sawtimber, 1.4 acres in logging slash, and 0.6 acres in disposed slash. Thus, while disposed slash has a greater lightning fire density than logging slash, fires in logging slash tend to burn more area than those in disposed slash.

D. Elevation Band

Lightning fire density increased steadily with increasing elevation on the Clearwater National Forest. Lightning fire density was lowest at 1000 to 1999 feet (5 fires/mm ac/yr) and highest at 6000 to 6999 feet (63 fires/mm ac/yr).

Lightning fire density was highest in valley bottoms and flats on the Deerlodge National Forest at 5000 to 5999 feet (43 fires/mm ac/yr), decreased through the next 2000 feet, and increased back to 21 fires/mm ac/yr at the 8000 to 8999 foot elevation band.

VI. FOOTNOTES

1. Bevins, Collin D.

-- 1979. Lolo National Forest lightning fire densities (1960 - 1974). Final report to Fire in Multiple Use Mgmt. RD&A Program, Northern Forest Fire Laboratory, Intermountain Forest & Range Experiment Station, Ogden, Ut. 43 p. illus. unpublished.

2. -- 1979. Kootenai National Forest lightning fire densities (1960 - 1974). Final report to Fire in Multiple Use Mgmt. RD&A Program, Northern Forest Fire Laboratory, Intermountain Forest & Range Experiment Station, Ogden, Ut. 44 p. illus. unpublished.

VII. PUBLICATIONS CITED

Arno, Stephen F.

-- 1976. The historical role of fire on the Bitterroot National Forest. USDA Forest Service Intermountain Forest & Range Experiment Station Research Paper INT-187. 29 p.

Stage, Albert R., and Jack R. Alley

-- 1972. An inventory design using stand examinations for planning and programming timber management. USDA Forest Service Research Paper INT-126, 17 p.